HYBRID GAS INFLATOR

FIELD OF THE INVENTION

The present invention relates to a hybrid gas inflator, and more particularly to a hybrid gas inflator used in the airbags in vehicles.

BACKGROUND OF THE INVENTION

For providing passengers with safety protection in accidents, an air bag system has become a standard device of modern day vehicles.

The gas inflation devices of the prior art for car air bags are categorized into full pressurized-gas type, gas-generant type, and hybrid type. The full pressurized-gas type directly uses a high-pressure gas stored in a high-pressure container to inflate an air bag. It is a disadvantage that this mechanism needs a larger quantity of gas and therefore the weight and size of the gas container cannot be too small. On the other hand, the gas-generant type uses propellant or pyrotechnics to generate a high-pressure gas to inflate an air bag; therefore, the size of the inflation device can be made small. But the solid impurities in the gas, a byproduct of combustion, are hazardous to humans and the environment. It is a further disadvantage that the hot gas may burn an air bag during a charging process. The hybrid type uses less amount of propellant or pyrotechnics to heat up and thereby expand a gas stored in a high-pressure container; therefore, the gas container can be small.

It is a further consideration that a pressure-resisting disc, without further

supportive components, seals the conventional high-pressure gas container. Therefore, the thickness of the pressure-resisting disc should be precisely designed that it not only sustain the gas pressure in the container but also can be easily broken when the charging process is activated. An improperly designed pressure-resisting disc may break up accidentally and cause a hazard to the passengers.

SUMMARY OF THE INVENTION

Accordingly, the primary object of the present invention is to provide a hybrid gas inflator that ejects a hot gas (a second gas), generated in a combustion chamber, into a high-pressure gas container to heat up another gas (a first gas) therein. The rapid thermal expansion of the hybrid gas increases the pressure available for charging an air bag, so that the size and weight of the inflation device is significantly reduced.

A second object of the present invention is to provide a hybrid gas inflator, wherein the impurities in the second gas ejected from the combustion chamber experiences two stages of condensation so that the impurities in the gas are mostly congealed and can be easily filtered out.

It is a further object of the present invention that the bottom end of the axle of the piston supports against the pressure-resisting disc so as to prevent it from accidental breakup.

It is a further object of the present invention that the second gas has exhausted its heat content during the process of heating up the first gas; therefore, the inflation device is safe and reliable.

To achieve the above objects, the present invention mainly comprises a high-pressure gas container, a connecting ring, a piston, and a combustion chamber. The high-pressure gas container contains a first gas therein and has an opening sealed by a pressure-resisting disc. An extension ring portion is formed around the opening of the high-pressure gas container, which has at least one exhaust outlet opened in radial direction. A connecting ring, is received within the extension ring portion. A partition plate at the middle level of the connecting ring separates the connecting ring into an upper ring and a lower ring. The lower ring has at least one gas outlet opened radially. The partition plate has a first central hole opened toward an axial direction. A piston includes an axle passing through the first central hole and sliding along the axial direction, a pressure-receiving portion formed on a top end of the axle. The bottom end of the axle extends to against the pressure-resisting disc covering the opening of the high-pressure gas container. The axle further contains an axial hole extending axially from the top end to the bottom end inside the axle. A combustion chamber, fixed within the extension ring portion, contains a predetermined amount of second gas generant therein. The combustion chamber has a gas exit corresponding to the pressure-receiving portion of the piston.

A second gas is generated by means of burning the second gas generant and escapes from the gas exit so as to press the pressure-receiving portion and to drive the piston to move axially along the axial direction. The axially moving axle, together with an axially flow of hot jet of the second gas passing through the axial hole therein, breaks the pressure-resisting disc. The second gas enters into the high-pressure gas container to mix with and heat up the first

gas in the high-pressure gas container. The first gas and the second gas forming a hybrid gas and flow out through the gas outlet of the connecting ring and the exhaust outlet of the extension ring portion.

Because the hot second gas from the combustion chamber simultaneously pushes the piston to break the pressure-resisting disc that seals the high-pressure gas container and flows into the axial hole of the piston, the first gas gets heated up and expanded by mixing with the second gas, and then gets ejected from the high-pressure gas container through of the exhaust outlet. The rapid thermal expansion of the hybrid gas increases the pressure available for charging an air bag, so that the size and weight of the inflation device is significantly reduced. Further, because the bottom end of the piston axle runs deep inside the high-pressure gas container, the mixing is sufficient and the heating is therefore efficient.

Further, when the second gas flows through the axial hole of the piston into the much wider high-pressure gas container, it expands and gets cooled; a first-stage process of condensation then occurs by which the majority of impurities in the second gas are congealed and will be kept in the container. As the hybrid gas of the first gas and the second gas flows out of the opening, a sudden pressure drop causes a further temperature decrease and therefore initiates a second-stage process of condensation. The impurities remained in the second gas are then solidified. A filter mesh covering the exhaust outlet of the extension ring portion can easily filter out these solid residues.

Further, when the inflation device of present invention is not in used, the axle of the piston can support the pressure-resisting disc to prevent it from accidental breakup.

The various objects and advantages of the present invention will be more readily understood from the following detailed description when read in conjunction with the appended drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 is an exploded view of a preferred embodiment according to the present invention.

Fig. 2 is a cross-sectional view of a preferred embodiment according to the present invention.

Fig. 3 illustrates the action of the combustion chamber of a preferred embodiment according to the present invention.

Fig. 4 illustrates the action of the piston of a preferred embodiment according to the present invention.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

Referring to Fig.1, a hybrid gas inflator according to the present invention comprises a high-pressure gas container 1, a connecting ring 2, a piston 3, and a combustion chamber 4. Fig.2 shows a cross-sectional view of the present invention when a process of inflation has not activated. The high-pressure gas container 1 can be a steel gas cylinder or a gas cylinder made of other materials. In this embodiment it is a steel gas cylinder in which a first gas 10 is stored. An opening 11 is formed on the top of the high-pressure gas container 1 and sealed by a pressure-resisting disc 12. In this embodiment the pressure-resisting disc 12 is a stainless steel disc; it can also be made of an

aluminum, a flexible metallic or a flexible non-metallic disc. Further, an extension ring portion 13 is formed on the top of high-pressure gas container 1 surrounding the opening 11. A plurality of exhaust outlets 131 in radial arrangement is formed on the wall of the extension ring portion 13.

The connecting ring 2 is received within the extension ring portion 13 and connected to the opening 11 of the high-pressure gas container 1. A partition plate 21 residing at the middle level of the connecting ring 2 divides the connecting ring 2 into an upper ring 201 and a lower ring 202. A plurality of gas outlets 221 in radial arrangement is formed on the wall of the lower ring 202. Further, a first central hole 211 is formed on the partition plate 21 at the center thereof, extending in the axial direction.

The piston 3 includes an axle 31 that passes through the first central hole 211 within the connecting ring 2. Guided by the first central hole 211, the piston 3 is allowed to slide along the axis of the connecting ring 2. An axial hole 311 is formed within the axle 31 along its axis, extending from the top end 312 of the axle 31to the bottom end 313 of the axle 31. The top end 312 of the axle 31 is formed a pressure-receiving portion 32, and the axle 31 is so extended that its bottom end 313 pushes against the pressure-resisting disc 12 at the opening 11 of the high-pressure gas container 1. Note that the bottom end 313 of the axle 31 pushing against the pressure-resisting disc 12 further prevents the hazardous accident of breakup of the pressure-resisting disc 12.

The combustion chamber 4, composed of an upper shell 43 and a lower shell 44 being crewed together, is fixed in the extension ring portion 13. The composition of the upper shell 43 and the lower shell 44 can also be achieved by rivet jointing or welding. The upper shell 43 and the lower shell 44 define a

hollow chamber 45, which contains a combustion-enhancement space 46 at the center surrounded by the second gas generant 401. A gas exit 41 is formed on the bottom of the combustion chamber 4 facing to the pressure-receiving portion 32 of the piston 3. To protect the gas generant in the combustion chamber 4 from moisture, a seal foil 42 made of aluminum is used to seal the gas exit 41. The combustion chamber 4 is separated from the piston 3 by a tray 6 installed within the extension ring portion 13. The tray 6 has a second central hole 61 in the corresponding position to the gas exit 41 of the combustion chamber 4 and is in contact with the pressure-receiving portion 32 on the top end 312 of the axle 31. The combustion chamber 4 is locked within the extension ring portion 13 by screwing a top cover 5 to the upper rim of extension ring portion 13. The composition of the top cover 5 and the extension ring portion 13 can also be achieved by rivet jointing or welding.

Fig. 3 shows the action of the combustion chamber 4 in the inflation process, wherein an igniter 461 in the combustion-enhancement space 46 ignites the combustion-enhancement 462 to produce a enhanced gas 464. The ehanced gas 464 flows through a plurality of gas outlets 463 on the wall of the combustion-enhancement space 46 into the hollow chamber 45 and then ignites the second gas generant 401 therein. The burning of the second gas generant 401 generates a second gas 40, which flows through a plurality of gas exiting holes 471 on a perforated plate 47, gathers in a space 472 and then breaks the seal foil 42 to leave the combustion chamber 4 through the gas exit 41.

Fig. 4 shows the action of the piston 3 on the pressure-resisting disc 12 activated by the second gas 40. Since the second central hole 61 on the tray 6

is larger than the axial hole 311 in the piston 3, the second gas 40 ejected from the combustion chamber 4 exerts a force on the pressure-receiving portion 32 and thereby drives the piston 3 to move axially. The axially moving axle 31 of the piston 3 and the high-pressure hot jet flow in the axial hole 311 together break through the pressure-resisting disc 12, by which the second gas 40 flows into the high-pressure gas container 1 to mix with and heat up the first gas 10. The hybrid gas of the first gas 10 and the second gas 40 is ejected from the high-pressure gas container 1 through the opening 11, the gas outlets 221 of the connecting ring 2, and the exhaust outlets 131 of the extension ring portion 13. Because the second gas 40 generated by the combustion chamber 4 is hot, it can heat up and increase the spressure of the first gas 10 in the high-pressure gas container 1 before exiting the container. Therefore, the size and weight of the inflation device is significantly reduced. Note that, as an extra advantage, at the same time the axle 31 breaks the pressure-resisting disc 12, the bottom end 313 of the axle 31 intrudes deep into the high-pressure gas container 1, which makes the second gas 40 can flow into the high-pressure gas container 1 deeply, and makes the mixing of the first gas 10 and the second gas 40 more efficient.

Further, when the second gas 40 flows through the axial hole 311 of the piston 3 into the much wider high-pressure gas container 1, it expands and gets cooled; a first-stage process of condensation then occurs by which the majority of impurities in the second gas 40 are congealed and will be kept in the container. As the hybrid gas of the first gas 10 and the second gas 40 flows out of the opening 11, a sudden pressure drop causes a further temperature decrease and therefore initiates a second-stage process of condensation. The

impurities remained in the second gas 40 are then solidified. A filter mesh 132 covering the exhaust outlets 131 of the extension ring portion 13 can easily filter out these solid impurities.

The present invention is thus described, and it will be obvious that the same may be varied in many ways. Such variations are not to be regarded as a departure from the spirit and scope of the present invention, and all such modifications as would be obvious to one skilled in the art are intended to be included within the scope of the following claims.